Verification Tests for LAT PS Science Requirements

Draft 0.4, S. Ritz, 15 March 2001
All numbers are TBR.

5.2.1 Energy range/effective area at 20 MeV, 100 MeV, 300 GeV.
A tagged photon beam is required to calculate the absolute efficiency and hence the effective area. Tagged photon beams at 20 MeV and 100 MeV are practical at SLAC. **>10,000 tagged photon triggers at 20±5 MeV and >5,000 tagged photon triggers at 100±10 MeV normal incidence are required.** These events will be passed through the trigger selections, full event reconstruction, and background rejection selections. The 300 GeV effective area will be obtained by analyzing **>1000 tagged photon triggers at 10±1 GeV and using the simulation to extrapolate to 300 GeV.** The simulation must be tuned to match the measured backsplash rate. The backsplash measurements from earlier beam tests should be reviewed and, if necessary, another set of measurements should be made at CERN.

More photons are required at lower energy because the effective area is lower.

5.2.2 Energy resolution at 20-100 MeV, 100 MeV-10 GeV, and 10 GeV to 300 GeV, normal incidence.
Although this can be done with either electron (or positron) or photon beams, it is highly desirable to do this with a photon beam. Converted gamma events are essentially early-showering events whose resolution is intrinsically different. Tagged photon beams with 5% resolution are sufficient at low energy. Although not explicitly stated in the requirements, the analysis for this verification test should be done separately for photon conversions in the Front and Back of the TKR. **The tagged photon events listed in 5.2.1 above are sufficient.**

5.2.3 Peak effective area.
>1000 tagged photon triggers at 1±0.1 GeV and 10±1 GeV will be passed through the trigger selections, full event reconstruction and background rejection selections.

5.2.4 Effective area knowledge
There are many components to this, and it requires review. However, the main ground-based test will be to **compare the simulation prediction with the measured values in 5.2.1 and 5.2.3**. The effective area is changing rapidly below 100 MeV, and this region must be mapped out carefully with high statistics (since the effective area is lowest here) and in <10 MeV energy bins.

5.2.5 and 5.2.6 68% and 95% containment on-axis.
Similar tests have been done in the 1997 and 1999 beam tests, and the events for 5.2.1, 5.2.2 and 5.2.3 can be used for the 68% containment test. **For the 95% containment test to be done well, we need a factor of 20 greater statistics, or >20k events in each energy/angle bin studied.** It is important to understand the tails of the PSF distribution using the beam. The 68% containment can be checked on-orbit with bright sources, but the 95% containment will be difficult to extract. Another driving issue for these tests is

the energy resolution of the photon tag for low-energy photons, since the PSF changes quickly with energy at low energy. In this case, 10% resolution is probably not sufficient. Special attention must be paid to the issue of multi-photon events in which only one of the photons converts in the TKR. NEEDS REVIEW.

5.2.7 PSF off-axis

The requirement specifies <1.7 times the value on-axis at ~55 degrees; however, this should be measured as a function of angle, impact position and conversion layer**. This requirement will likely drive the total tagged photon beam time, and should be REVIEWED CAREFULLY. This test also requires a translation/rotation table and associated fixtures for the calibration units. This test will drive the number of towers we need in the beam.**

5.2.8 Field of View

This requirement is expressed as an integral, so **the effective area must be measured over >5 angles from 0 to 80 degrees using >1000 tagged photon events in at least one energy bin from 1 GeV to 5 GeV**. As in 5.2.7, the number of towers needed in the beam at any one time must be carefully evaluated.

5.2.9 and 5.2.10 Source Location Determination and Point Source Sensitivity

These are **verified via analysis**, using the measured PSF and Aeff. and a sky simulation.

5.2.11 Time accuracy

This test will be performed using a beam (photons or electrons), and running the instrument in a self-triggered mode. **The (event-time – beam clock phase) distribution will be histogrammed for beam energies of 20 MeV, 100 MeV, and 10 GeV**.

5.2.12 Background rejection

REQUIRES CAREFUL REVIEW. **>10M protons at 100 MeV-10 GeV and > 100k electrons at 100 MeV-20 GeV are required**.

5.2.13 Dead time

The energy dependence of the deadtime will be measured using **electron and photon events from 100 MeV to 10 GeV, and multi-electron events with effective energies up to 300 GeV**. **Events from the other tests can be used for this purpose, provided the instrument is in self-triggered mode**. Dead times for the full instrument will be measured using cosmic rays and by reducing the TKR and CAL trigger thresholds to raise the L1 rate to 10 kHz.

5.2.14 and 5.2.16 GRB and AGN location Accuracy on-board

These requirements will be **verified using the simulation and the measured PSF and Aeff**.

5.2.15 and 5.1.17 GRB and AGN notification time to the spacecraft

These requirements will be verified using the full instrument and spacecraft simulator, by pre-loading simulated event data into the DAQ system.